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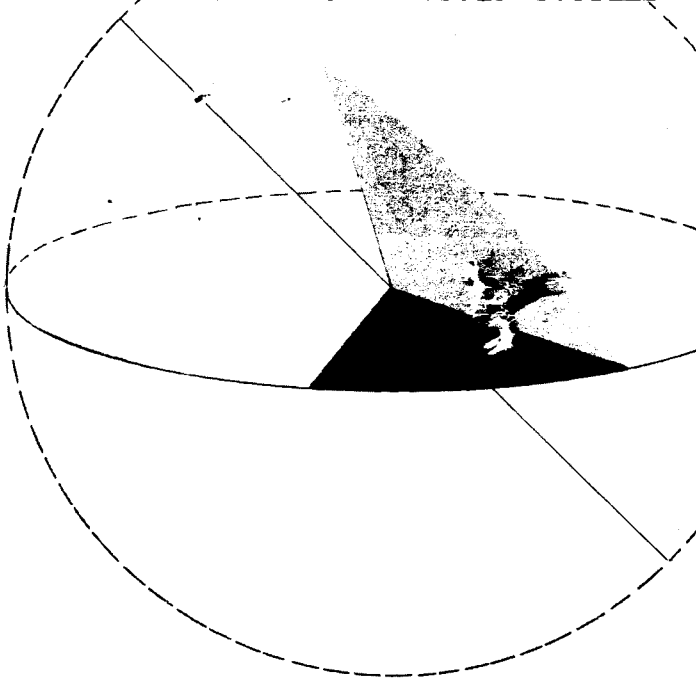

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DESTINATION--VENUS

Communiques and Papers From the Soviet Press, February 12-March 3, 1961

Compiled and translated by
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CALIFORNIA INSTITUTE OF TECHNOLOGY
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DESTINATION--VENUS

Communiques and Papers From the Soviet Press,
February 12-March 3, 1961

PREFACE

This publication is a collection of translations of Soviet radio and press reports on the launching, progress, and failure of the Automatic Interplanetary Station which was launched by the Soviet Union toward the planet Venus on February 12, 1961.

This report contains communiques and papers which were released by the Soviet Union between February 12 and March 3, 1961.

This report is offered with the double purpose of presenting information on Soviet deep space research and of affording an estimate of the Soviet press and general reaction to such research.

Joseph L. Zygielbaum

DESTINATION--VENUS

Communiques and Papers Taken From the
Soviet Press, February 14-19, 1961

Report No. 1

RADIO MOSCOW (9.775 mc), 1405 PST, February 12, 1961

Persistent experiments have finally resulted in a successful launching of a deep-cosmic probe from an orbiting satellite. On two previous occasions, the Soviet Union has experimented in placing heavy satellites in parking orbits.

On February 11, 1961, the Soviet Union launched a heavy satellite into a 625 km parking orbit. After the satellite was stabilized and it achieved the necessary coordinates, a signal was given from a ground station. In response to that signal, an automatic interplanetary observatory was launched from the satellite toward the planet Venus; the space probe, which is guided by telemetry from the ground, achieved the necessary escape velocity.

The weight of the interplanetary station is 643.5 kg. The station carries a pennant with the Soviet emblem which will be deposited on the surface of Venus, if the experiment is successful. The station is heavily equipped with transmitters and other telemetry equipment. Transmissions are made on six frequencies, two of which are 922.8 mc and 183.6 mc. The signals are loud and clear. Tracking stations around the world have been alerted, and they are participating in tracking the interplanetary station.

As of 1200 Moscow time, February 12, 1961, the coordinates of the interplanetary station were as follows: 86° 40'E longitude and 6° 4'N latitude. The distance of the station from the Earth at that time was 126,300 km.

The satellite, which carried the interplanetary station to its parking orbit, was launched with the help of a multistage rocket.

The interplanetary station should reach Venus in the latter part of May, 1961. The main purpose of this experiment is to check possibilities of placing rockets on an interplanetary trajectory; checking super-long-range radio communications and cosmic-station guidance; and ascertaining with greater exactitude the scope of the solar system and conducting similar types of physical research in outer space.

RADIO MOSCOW (9.800 mc), 2100 PST, February 13, 1961

The interplanetary station is traveling along a perfect trajectory for an orbit around Venus.

At 900 GMT, the station was traveling at a velocity of 14,000 ft/sec; the temperature at that time was +68° F.

The station is sending back information on the following:

(1) Cosmic rays

(2) Magnetic field

(3) Micrometeorite impact

(4) Interplanetary matter

(5) Temperature inside the station

(6) A device for distance measurements

The power supply consists of chemical batteries which are charged periodically by solar batteries. The interplanetary station will be interrogated every 5 days.

At 900 GMT the station reached a distance of 306,000 miles from the surface of the Earth; the stations coordinates were 53'N latitude and 88° 2'E longitude. The station was in the vicinity of the constellation of Pisces.

IZVESTIA, February 14, 1961
TASS Communique

In accordance with the program for the investigation of outer space, the Soviet Union has placed in orbit a heavy artificial Earth satellite on February 12, 1961. The satellite was placed in orbit with the help of a multistage rocket.

During that same day a guided rocket which was launched from aboard the satellite injected an automatic interplanetary station on a trajectory toward the planet Venus.

The automatic interplanetary station will reach the area of the planet Venus in the second half of May, 1961.

The principal tasks of this launching are to check the methods for the injection of cosmic objects into an interplanetary path; to check long-range radio communication and guidance of the cosmic station; the perfection of measurements of the solar system; and the conduction of a number of physical investigations in space.

The instruments which are installed aboard the interplanetary station are operating in a normal manner. The weight of the automatic interplanetary station is 643.5 kg.

Radio transmissions from aboard the interplanetary station are made on a frequency of 922.8 mc by command from Earth.

The automatic interplanetary station carries in its nose a pennant with the image of the State Emblem of the USSR.

Special tracking centers are following the progress of the interplanetary station.

According to obtained data, the movement of the automatic interplanetary station is traversing an orbit which is very close to the calculated.

At 1200 Moscow time, February 12, 1961, the interplanetary station was at a distance of 126,300 km from the surface of the Earth and above a point on the Earth's surface having geographical coordinates of 86° 40'E longitude and 6° 4'N latitude.

The successful launching of a cosmic rocket toward the planet Venus actually paves the way for interplanetary flights to planets of the solar system.

PRAVDA, February 14, 1961
TASS Communique

The automatic interplanetary station continues its flight along the desired route.

At 1200 Moscow time, February 13, 1961, the station has departed from Earth to a distance of 488,900 km and passed over a point with the geographical coordinates of 0° 53'N latitude and 88° 2'E longitude. The station was located in a region of the firmament (Fig. 1) which is adjacent to the constellations of Cetus and Pisces, in the center of a triangle formed by the constellations of β Aries, α Pegasus, and β Cetus.

Trajectory measurements which were obtained have shown that the heavy artificial Earth satellite was injected with great preciseness into a precalculated orbit around the Earth. The cosmic rocket which was launched from the satellite has secured an accurate injection of the automatic interplanetary station into a flight trajectory toward the planet Venus.

The flight speed of the interplanetary station in the beginning of the trajectory toward Venus has exceeded the magnitude of the second cosmic velocity. During its subsequent flight, the velocity of the interplanetary station began to decrease due to the influence of the Earth's gravitational pull. At noon on February 13, the speed of the interplanetary station's departure from the Earth was 4,050 meters/sec. After a few days of flight, the automatic interplanetary station will leave the boundaries of the so-called "sphere of the Earth's gravitation," having a velocity somewhat less than 4 km/sec.

Scientific instrumentation which was installed aboard the automatic interplanetary station was designed for the investigation of cosmic rays, magnetic fields, interplanetary matter, and the registration of collisions with micrometeorites.

For the purpose of securing operational conditions for the instruments, the temperature aboard the interplanetary station is maintained within predetermined limits with the help of a temperature regulating system.

Aboard the station is installed an electronic technical system which is designed for solving the following problems:

(1) The measurement of flight parameters of the station in relation to the Earth.

(2) Transmission to Earth of measurement results which are being conducted aboard by the scientific instrumentation.

(3) Transmission to Earth of information on the operational mode of all systems and installations aboard the spaceship.

During the periods of interrogation the instrumentation is powered by chemical power-sources which are continuously charged during the flight by energy from solar

batteries. The assurance of continuous illumination by the Sun of the solar batteries (in order to obtain the maximum energy from them) is conducted with a solar orientation system.

After the launching of the interplanetary station, two communication sessions took place. During these sessions, trajectory measurements were conducted, and a large volume of radio telemetry information was received.

According to data which was obtained at the computation center, all systems aboard the automatic interplanetary station have functioned in accordance with the program. During the last interrogation, the temperature aboard the station was +20° C. The solar batteries were correctly oriented in relation to the Sun and they delivered the necessary current. Processing of the obtained telemetry information continues.

Communication with the automatic interplanetary station will be conducted once every 5 days.

Communiques on the progress of the station and the measurement results will be published once every week.

RADIO MOSCOW (9.8 mc), 2215 PST, February 14, 1961

Due to a decrease in velocity of the Interplanetary Station, a revision of the original program resulted in the trajectory of the Station being corrected in such a manner as to advance the Station's interception of the planet Venus by approximately one month.

New coordinates will be reported when available.

THE DISTANT PLANET VENUS

by

Professor I. Shklovsky

Izvestia, February 14, 1961

"On the distant planet Venus,
The Sun is more flaming and golden.
On Venus, on Venus,
The trees must have gray leaves . . ."

These verses were written 40 years ago by the Russian poet, Gumilev. The gray leaves of Gumilev are actually a poetical metaphore. Gumilev was a fine poet; however, he could not foresee the birth of a new science--astrobotanics. In accordance with the founder of this science, G. A. Tikhov, "gray leaves" should be present in Martian plants while these are getting accustomed during their long evolution to the harsh conditions of that planet. On Venus, to the contrary, because "the Sun is more flaming and golden," the leaves of trees, according to Tikhov, should be of an orange or even red coloring.

At present even science-fiction writers will have to give up their dreams about the breath-taking landscape of our cosmic neighbor. Observations during the past two years have shattered all our illusions in regard to the beautiful flora and fauna of Venus.

What has happened in science?

It is a well-known fact that the planet Venus is wrapped in a thick layer of clouds. The clouds are so dense that the surface of the planet cannot be seen at all. This is the reason why astronomers have known almost nothing about the physical conditions which prevail on the surface of Venus. The period of rotation around its axis

is still unknown. We have sufficient knowledge only about the mass of the planet, and dimensions and characteristics of its movement around the Sun (mean distance from the Sun and its orbital period).

Only the upper most layers of the Venus atmosphere (which were discovered exactly 200 years ago by the great Lomonosov) could have been studied with astrophysical methods. The chemical contents of the "peak" of the Venus atmosphere proved to differ strongly from the Earth's atmosphere. The largest component in the Venus atmosphere seems to be carbon dioxide. Several years ago, the Soviet astronomer Kozyrev observed the illumination of the night sky of Venus. This illumination proved to be quite bright. The spectroscopic method which was applied by Kozyrev made it possible for him to discover bright belts in that illumination, obviously being caused by the molecules of nitrogen. Thus it was proven that in the atmosphere of Venus there is nitrogen. This is quite natural. As is known in the atmosphere of the Earth, nitrogen has a secondary origin. That means that nitrogen was not present in our atmosphere from the beginning, but it was gradually "vaporized" from the hard crust. The same process obviously took place also on the planet Venus.

Only quite recently weak belts of water vapor were discovered in the spectrum of the Venus atmosphere. It is quite clear that the discovery of water vapors in the upper layers of the Venus atmosphere are of utmost importance.

All attempts to discover oxygen in the atmosphere of Venus were unsuccessful. It is possible to make a conclusion from this fact: that if oxygen exists in the atmosphere of Venus its amount must be a thousand times less than in the atmosphere of the Earth.

To the afore mentioned skimpy list of information about Venus, some data should be added in regard to temperature measurements of the cloud layer which is visible from the Earth. This in detail concludes our knowledge of the planet Venus up till now.

An essential change took place about two years ago, when to the aid of optical astronomy came radio astronomy. With the help of large radio telescopes and very sensitive receivers, Soviet and American radio astronomers succeeded in measuring the flux of radio emission from Venus at wavelengths within the ranges of 8 mm, 3 and 10 cm. Soviet observations were conducted by A. V. Kuzmin and A. E. Salomonovich with a 22 meter radio telescope of the Physics Institute of the Academy of Sciences,USSR.

A very valuable property of radio waves is the fact that they are capable of passing freely through dense clouds. Consequently, the source of radio emission of Venus is its surface, and not the cloud layer.

As is well known, all heated bodies emit a broad spectrum of electromagnetic waves including radio waves. Therefore, by knowing the flux of radio emission from Venus, and also the distance to that planet and its dimensions, it is possible, with the help of simple physical formulas to determine the temperature of the radiating surface. The results were remarkable. According to observations on the wavelengths of 3 and 10 cm, the temperature in certain regions of the Venus surface proved to be about +300°C. Soviet observations at a wavelength of 8 mm gave a somewhat lower value for the temperature, which obviously can be explained by the fact that the radio waves with the 8 mm length are partially absorbed by the atmosphere of Venus.

We will also mention that this temperature is an average between the day and night values, since the illuminated part of the planet is visible in the form of a bright narrow sickle (Fig. 2). Kuzmin and Salomonovich have found a systematic increase of the average temperature as the illuminated part of the planet changes due to the orbital rotations of Venus and the Earth. There is, therefore, a basis to assume that during the daytime the temperature on Venus is even higher.

What is the reason for such a high temperature on the surface of Venus? Of course the full theory of this phenomena is as yet not worked out since very little time has passed from the moment when the above described observations began.

It is a well known fact why under the glass of greenhouses fruits and plants can grow in the winter time. The solar rays freely penetrate through the glass and heat up the internal surface. The heated surface emits invisible infrared rays which are trapped by the glass. Infrared heat rays remain in the greenhouse and maintain there a warm temperature. Exactly the same process takes place on Earth. The role of the glass is played by our atmosphere. The atmosphere of Venus represents with itself a more complete greenhouse than the Earth; therefore, the temperature of the surface of the planet is very high in spite of the fact that at the summits of the cloud layer prevails a -40° C frost.

On the basis of all available radio astronomical and optical observations, we are now capable of constructing a very preliminary model of the atmosphere of Venus. First of all we must answer the question: which molecules in the Venus atmosphere cause the "greenhouse effect". Obviously these can be only molecules which absorb very strongly over the entire infrared part of the spectrum. It seems that only molecules of water vapor might give such an absorption. For this purpose, not too many

molecules are necessary--only several grams above each square centimeter of the planet's surface. This exceeds only by several times the average content of water vapor in the Earth's atmosphere. The basic part of the Venus atmosphere below the cloud cover should consist of carbon dioxide as was shown by calculations. The atmospheric pressure on the surface of Venus is approximately five times larger than on the surface of the Earth. As can be seen, the atmosphere of Venus is sufficiently dense. In addition to carbon dioxide, the Venus atmosphere should contain also molecular nitrogen. The amount of this nitrogen, as can be assumed, is approximately the same as in the Earth's atmosphere.

Venus obviously rotates around its axis quite slowly. This was derived from observations of the thermal regime of the planet.

At a pressure of about 5 atm and a temperature of +300° C or more, it is almost certain that there are no seas on the surface of Venus.

How dark the world must be. Red-hot rocks, complete absence of water basins, a dense carbon dioxide atmosphere, and a heavy overcast which covers the entire sky. Through that overcast the Sun or stars cannot be seen at all. How different this picture appears from the colorful picture described in the poem which precedes this article.

The two sister planets Earth and Venus bear no resemblance at all. A great role in the fate of these sister planets was played by the varying distances from the Sun. From this example, we can see that closeness to the Sun is much more harmful for the development of life than a larger distance.

It is understood that the above described physical conditions of Venus are very primitive, and in the future our knowledge of these conditions will be improved as

time goes by. An important role in the improvement of our knowledge on the nature of Venus should be played by investigations with the help of automatic interplanetary stations. The first such station was successfully launched on February 12, 1961, in the direction of that planet (Fig. 3). We must be patient and wait for the valuable information about our cosmic neighbor, which will begin to arrive to us in May of this year. We should also keep in mind that one such flight will not solve all problems which are placed before science. The first flight will be followed by more such interplanetary stations. The scientific instruments will become more perfected. The time is not far away when Venus will not have any mysteries hidden from mankind.

THE PLANET OF MYSTERIES

by

A. Severnyi

Member Correspondent of the Academy of Sciences USSR
Director of the Crimean Astrophysical Observatory
per Izvestia, February 15, 1961

The interplanetary automatic station is traveling now at a distance of hundreds of thousands kilometers from the Earth in a space the nature of which we know very little.

All preceding flights into space of our satellites and rockets have made it possible to explain conditions in which the instruments aboard these satellites and rockets have to operate. Transmissions which were received from these flying stations testify to the fact that the instruments aboard these stations operate in a very satisfactory manner.

A gigantic trip of about 50 milliom km is in store for the interplanetary station headed toward Venus. Its flight will last about 100 days. Meteors, cosmic rays, and other particles with high energies will continue to bombard the body of the interplanetary station and its instruments during that period of time.

Of extreme scientific interest and practical value is the problem of the extent of radiation effects, particularly these effects which are connected with the activities of the Sun and the radiation caused by solar explosions.

It was discovered not so long ago that the occurrence of explosions on the Sun is accompanied in the majority of cases with a discharge of protons of high energies from 10 to 100 mev. On one hand this is a serious danger for live organisms, and on

the other hand these particles with high energies might have a strong effect on the results of measurements. For instance, a common photo plate designed for photographing the surface of the planet might prove to be hopelessly "over exposed" after a presence of several days in space even if it were well protected against light.

Investigations of radiation and many other effects during extended flights in space represent an important problem which is being encountered in the beginning of the era of interplanetary exploration.

As far as science is concerned, of great importance is also the investigation of the discharged solar corpuscular fluxes and the investigation of magnetic fields which these corpuscles carry with them.

Investigation of magnetic fields in interplanetary space is of great value for the explanation of the nature of corpuscular fluxes which originate on the Sun and the conditions of propagation of cosmic rays in our planetary system (Fig. 4). Very interesting data in this respect were obtained with the help of the second Soviet Lunik and the American cosmic rocket "Pioneer VI". These data indicated a fine structure of the magnetic field in interplanetary space and a simultaneous advance of magnetic disturbances on the rocket as well as on the Earth. It is possible that this has to do with a very rapid propagation of carriers of cosmic magnetic fields.

The planet Venus, toward which our cosmic laboratory is now speeding, is 1.5 times closer to the Sun than the Earth. The study of the movement of the guided interplanetary station will permit us to pinpoint more accurately not only the distance to that planet but also the value of the basic unit of distance in our solar system--the distance from the Earth to the Sun which is known as an astronomical unit. This is of utmost importance for future interplanetary exploration.

The dimensions of Venus are very close to the dimensions of the Earth. The surface of this planet is always hidden from us by a dense cloud cover. The structure and contents of the Venus atmosphere is in many respects still unknown to us. Its temperature varies from -50 to +300° C, although we do not know yet for sure to what in the Venus atmosphere these dimensions pertain. Spectroscopic investigations made by astronomers have so far enabled them to establish reliably the presence of a large quantity of carbon dioxide gas in the atmosphere of Venus. Not so long ago water vapors were found in that atmosphere. If oxygen is present there, it must be in very small quantities.

Obviously electrical discharges occur in the Venus atmosphere that are similar to our thunders but far more forceful. We have no definite knowledge in respect to the rotation of this planet; however, the majority of data points to the fact that this rotation is slow--considerably slower than the rotation of the Earth. We do not know at all how far the atmosphere of this planet extends. Does it have an ionosphere similar to our Earth, radiation belts as well as an extended corona similar to the Earth's geocorona?

It will be possible to obtain data on the structure and nature of the planets and their atmospheres only with the help of extremely precise and reliable instruments. Of no less importance is also the reliability of communications between the interplanetary station and the Earth at huge distances. The flight of the interplanetary station testifies to the fact that the gigantic difficulties on this road are being overcome by science and technology.

PRAVDA, February 19, 1961

TASS Communique

The flight of the Soviet automatic interplanetary station toward the planet Venus continues.

In accordance with the adopted program, a consecutive interrogation of the automatic interplanetary station took place on February 17 at 1404 Moscow time. At that time the automatic interplanetary station was located at a distance of 1,889,000 km from the surface of the Earth (above the Indian Ocean) at a point with the coordinates of 0° 39'S latitude and 54° 37'E longitude. The speed of departure of the interplanetary station from Earth was 3,923 meters/sec.

The interplanetary station still remains in a sector adjacent to the boundaries of the constellations of Pisces and Cetus, on a straight line between the stars β Cetus and α Andromeda. The right ascension of the automatic interplanetary station at that time was 0° 27'10"; the declination was -0.38'50".

During the interrogation a great amount of radio telemetry information was obtained, measurements of the trajectory elements were conducted, and the velocity of the interplanetary station was determined.

Commands, which were given from the Earth, were received and carried out by the instruments aboard the station.

The processing of results of trajectory measurements have confirmed the fact that the interplanetary station continues its flight toward Venus along a trajectory which is close to the calculated. Preliminary data, which were obtained after the mathematical processing of measurements during the initial sector of the trajectory,

indicate that the automatic interplanetary station, after traveling along its orbit a distance of about 270 million km, will (without trajectory corrections) pass at a distance of more than 180,000 km from the center of the planet Venus. At that moment the automatic interplanetary station will be at a distance of about 70 million km from the Earth.

The instruments aboard the interplanetary station are functioning normally.

According to telemetry data, the temperature inside the station has been 28 to 30°C, and the pressure 900 mm Hg. The solar cells are operating reliably, and the charge of current of the chemical batteries is very satisfactory.

Results of measurements which were conducted with the help of the scientific instruments for the investigation of cosmic space are being processed now.

On February 19 at 1200 Moscow time, the interplanetary station will be at a distance of 2,537,000 km from the surface of the Earth.

RADIO MOSCOW (9.600 mc), 2015 PST, February 21, 1961

At 0600 Moscow time, February 21, 1961, the automatic interplanetary station reached a point 2,115,000 miles from the Earth's surface, still traveling over a trajectory which is very close to the calculated. It is now definite that the station will reach the vicinity of Venus in the second half of May. Our tracking stations at Irkutsk, Yakutsk and Mirnyi in the Arctic are making preparations for the interrogation of the automatic interplanetary station.

At Yakutsk a special institute and observatory was recently completed for the study of cosmic rays. This is the most advanced geophysical station of the Siberian Branch of the Soviet Academy of Sciences. The Yakutsk coordinates are 62°30'N latitude and 128°E longitude.

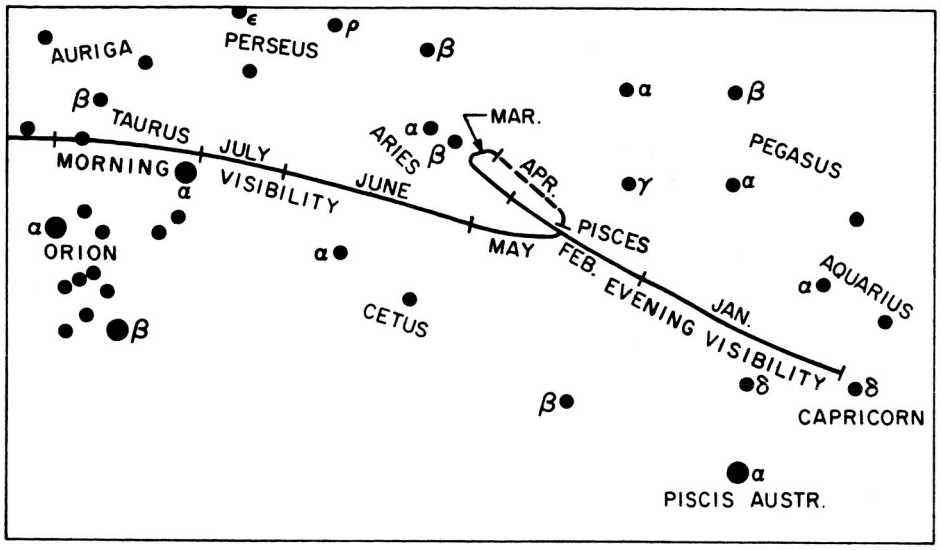


Fig. 1. Path of Venus across firmament

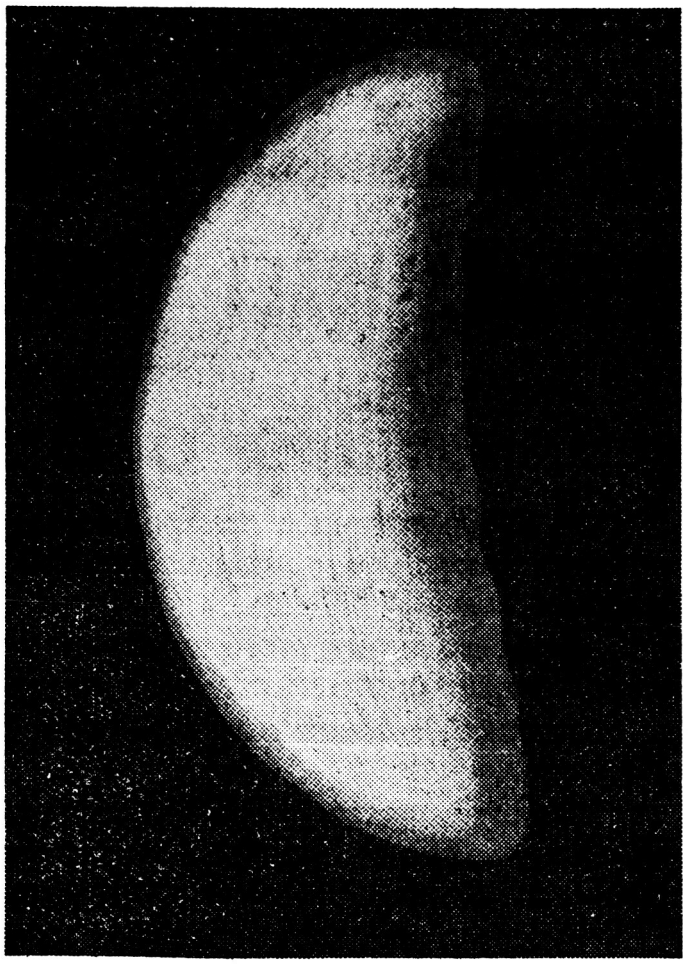


Fig. 2. Venus as photographed through 100 inch telescope

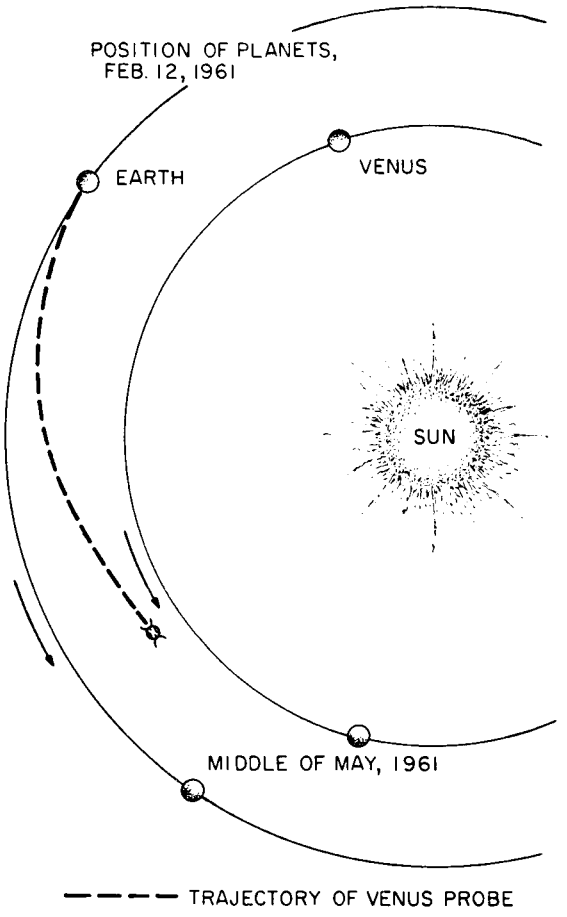


Fig. 3. Earth-Venus relationship during flight of interplanetary station

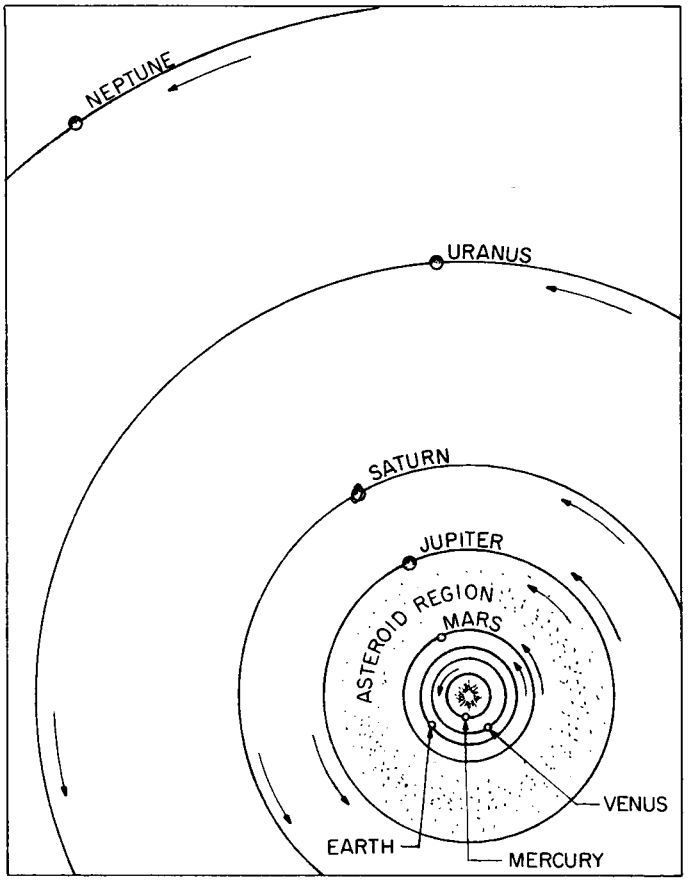


Fig. 4. Sector of solar system

THE FIRST FLIGHT TOWARD THE PLANET VENUS

Pravda, February 26, 1961

1. THE FLIGHT OF THE AUTOMATIC INTERPLANETARY STATION

On February 12, 1961, began from the territory of the Soviet Union a flight of an automatic interplanetary station on a trajectory toward the planet Venus.

After launchings of artificial Earth satellites, flights toward the Moon and a flight along an orbit around the Moon, during which photographs of the hidden side of the Moon were taken, a new era began in the conquest of cosmic space and the investigation of planets of the solar system. The first flight of a cosmic vehicle toward our nearest neighbor planet Venus was undertaken.

Powerful motors accelerated a multistage rocket, increasing its speed and distance of flight above the surface of the Earth. The guidance system directed the rocket along a predetermined trajectory. When the rocket speed reached the first cosmic velocity, a heavy satellite which carried a cosmic rocket with an interplanetary station aboard was separated. The satellite was in almost a circular orbit with a minimum distance from the center of the Earth of 6,601 km, and a maximum distance from the center of the Earth of 6,658 km, with an orbital inclination toward the equator of 65 degrees.

The cosmic rocket was launched from aboard an artificial Earth satellite at a precalculated point on its orbit. When the speed of flight of this rocket in relation to the Earth surpassed the second cosmic velocity by 661 meters/sec and the rocket entered a precalculated point in space, the rocket motor was shut off and the

automatic interplanetary station was separated. The free flight of that station on a trajectory toward the planet Venus began.

In this manner was accomplished for the first time in history the launching of a guided interplanetary station from aboard an artificial Earth satellite over an interplanetary route. From then on the movement of the automatic interplanetary station took place under the influence of gravitational forces from the Earth, Sun, and the planets. The Earth's gravitational forces have a considerable effect on the movement of the automatic interplanetary station at distances up to 1 million km from the center of the Earth. The sphere with a radius of 1 million km which surrounds the Earth is called the "sphere of the Earth's influence ". After leaving this sphere of the Earth's influence, the movement of the automatic interplanetary station is affected basically by the gravitational forces of the Sun, and the station travels then in accordance with the laws of motion of all planets of the solar system.

Inside this sphere of the Earth's influence, the automatic interplanetary station traveled over a curve which was close to hyperbolic. This curve is located in a plane which passes through the center of the Earth and is unchangeably oriented in relation to the stars. This plane is close to the one in which the satellite traveled. During its departure, the speed of the automatic interplanetary station in relation to the Earth decreased gradually. The automatic interplanetary station reached the boundaries of the Earth's sphere of influence on February 14 at 2300 Moscow time, and its velocity was about 4 km/sec in relation to the Earth.

The speed of the interplanetary station in relation to the Sun was obtained by computing the vector of the Earth's speed in relation to the Sun and the vector of the speed of the automatic interplanetary station in relation to the Earth. At the moment

of exit from the sphere of the Earth's influence the speed in relation to the Sun was 27.7 km/sec.

After this the movement of the automatic interplanetary station, as well as the movement of the planets, takes place over an elliptic orbit with its focal point at the center of the Sun. The values of this orbit are as follows:

Maximum distance from the Sun (Aphelion)	151 million km
Minimum distance from the Sun (Perihelion)	106 million km
Inclination toward the plane of the ecliptic (i.e., toward the plane of the Earth's orbit)	0.5 degrees

The planes of motion of the Earth, Venus, and the automatic interplanetary station are very little inclined toward each other.

In Figure 1 is illustrated the movement of the automatic interplanetary station, the Earth, and Venus projected on the plane of the ecliptic. The movements of the Earth and Venus take place along orbits which are very close to circular. The simultaneous position of the Earth, Venus, and the automatic interplanetary station is indicated by connecting straight lines. In the beginning of its movement around the Sun, the rocket departs from the Earth. Just before the day of the vernal equinox, the Sun, the automatic interplanetary station, and the Earth will be approximately on a straight line. After that the rocket will surpass the Earth in an angular motion around the Sun. The distance from the Earth to the automatic interplanetary station during the entire duration of its flight toward Venus will increase continuously, and at the moment of approach it will be 70 million km.

The angle between the directions from the center of the Sun to the Earth at the moment of start and to Venus at the moment of approach by the interplanetary station

will be 120 degrees. The travel time of the interplanetary station up to the moment of approach with Venus will be a little over 3 months. The station's approach to Venus will take place between the 19 and 20 May 1961.

Just like the Earth, Venus also has a sphere of influence, with a radius of 600,000 km. Inside that sphere, the influence of Venus on motion is prevailingly stronger than the influence of the Sun. The movement of the station in relation to Venus inside its sphere of influence will take place over a trajectory which will be close to hyperbolic with its focal point at the center of Venus.

A calculation in accordance with obtained data of orbital measurements shows that the automatic interplanetary station will penetrate deep into the sphere of influence of Venus. The minimum distance of the automatic interplanetary station from Venus during its approach over the same trajectory along which it is now traveling, will be less than 100,000 km, compared to the over-all distance of travel which is 270 million km. This testifies to the high accuracy of injection of the automatic interplanetary station into its trajectory.

If the interplanetary station was a bright point, then it would have been possible to observe from the Earth the shifting of the station on a background of stationary stars. The position of the station on the firmament is represented in the astral chart which is enclosed (Fig 2).

In the beginning of its travel, the shifting of the station in relation to the stars was rapid. During its exit from the sphere of influence of the Earth, the station was located in a sector of the sky which is adjacent to the constellation of Cetus and Pisces, in the center of a triangle formed by the stars β Aries, α Pegasus, and

β Cetus. At this moment, the angular movements of the automatic interplanetary station in the sky were already very slow. At this sector, the automatic interplanetary station travels in relation to the Earth approximately along its radius.

As can be seen from the enclosed chart (Fig 2), the further movement of the automatic interplanetary station on the background of the firmament is identical to the movement of the planets. Up to the beginning of April, the automatic interplanetary station will remain in the constellation of Pisces, shifting around with a so-called loop-like motion. In the beginning of April, the automatic interplanetary station will start to move across the firmament in a straight line. The point when the loop-like motion changes into a straight line is called the "point of standing ". The straight motion among the stars will continue up to the moment of the station's approach to Venus, which will take place not far away from ϵ Pisces.

At the moment of start of the automatic interplanetary station, the planet Venus was located in the constellation of Pisces, moving around among the constellations in a straight line. That straight motion gradually slows down and at the end of March Venus reaches its standing point. Past that standing point begins the loop-like motion of Venus which continues to the beginning of May, 1961, and is then replaced by a straight motion again. At this sector of straight line motion of Venus will take place the approach of the automatic interplanetary station to that planet.

2. SELECTION OF A FLIGHT TRAJECTORY

In order to accomplish a flight toward Venus, it was necessary to select a flight trajectory which will satisfy a number of conditions. If the date of the rocket's start and the date of its approach to Venus are set, then the orbit of the automatic

interplanetary station in the solar system outside of the sphere of influence of the Earth will definitely be determined. After leaving the sphere of the Earth's influence, the automatic interplanetary station should, thereby, achieve a speed which is fully determined beforehand in regard to its magnitude and direction. However, in the case of an unsuccessful selection of a starting date and date of approach, the value of the necessary speeds would be so great that the acceleration of the automatic interplanetary station of even a very small weight could not be achieved even with the help of the most powerful technically designed rockets. For that reason, the starting date and the date of approach are selected in such a manner that the necessary velocity of exit of the automatic interplanetary station from the sphere of influence of the Earth would be as low as possible. Thereby, the speed value which the carrier rocket should transfer to the automatic interplanetary station at the acceleration sector will also be at a minimum.

Of essential value is the method of acceleration of the automatic interplanetary station by the carrier rocket. During the continuous operation of all stages of the rocket, the weight of the payload depends not only on the speed value which should be transferred to the automatic interplanetary station at the final sector of acceleration, but also on the angle of inclination of the velocity toward the horizon. In the case of large inclination angles of speed, the Earth's gravitational force will interfere with the acceleration. It is, therefore, easier to transmit the desired velocity in a horizontal direction; large inclination angles,on the contrary, might lead toward an excessive consumption of fuel and large losses in weight of the automatic interplanetary station. In order to assure the exit of the automatic interplanetary station from the sphere of the Earth's influence with a velocity in the necessary direction, it might be

required during an uninterrupted acceleration to develop a velocity in a curved line toward the horizon.

This can be avoided if one applies the method of acceleration with an intermediate exit on an orbit of a satellite. A satellite which carries aboard a cosmic rocket is injected by a carrier rocket into a circular orbit with minimum losses. The acceleration of the cosmie rocket which is launched from aboard that satellite is conducted in an almost horizontal direction. By selecting in a proper manner the plane of the satellite's orbit, and the time and place for starting of the automatic interplanetary station from the satellite, it is possible to secure the exit of the station from the sphere of the Earth's influence with a necessary speed direction.

The presence of a powerful carrier rocket and the application of a launching from aboard a satellite made it possible to inject an automatic interplanetary station with a weight of 643.5 kilograms on an interplanetary orbit toward Venus. By utilizing the launching from a satellite, an advantage is achieved to develop necessary accelerations of space probes not only toward Venus but in various cosmic directions.

As we have already mentioned, the starting date and the date of approach to Venus are selected in such a manner that the speed value of exit of the automatic interplanetary station from the sphere of the Earth's influence is as small as possible. This determines a number of ranges of dates for starting and approach, which are convenient from the viewpoint of rocket energetics. The acceptable intervals of starting dates are from 1 to 2 months, and they are repeated periodically approximately every 19 months. One such interval falls on the end of 1960 and the beginning of 1961. This interval was utilized during the launching of February 12.

After leaving the sphere of the Earth's influence, the automatic interplanetary station entered an elliptical orbit for a periodic flight around the Sun. In connection with this problem, the flight duration up to the moment of approach to Venus might vary strongly in the case of various energetically convenient trajectories. There are trajectories by the utilization of which the automatic interplanetary station would have intercepted Venus during the first half of its orbit around the Sun, or during the second half of its orbit around the Sun, etc.

For the launching of February 12 was selected a trajectory by which the interception would take place during the first half of the rocket's orbit around the Sun. Other trajectories have certain deficiencies in comparison with this one: the flight duration increases essentially; also essentially increases the dependence of the magnitude of inclination of the automatic interplanetary station toward Venus on errors during the final sector of acceleration. In addition, the distance from the Earth to Venus at the moment of approach with that planet would be considerably larger in the case of the other trajectories than it will be in the one that we have selected.

In order to assure the approach of the automatic interplanetary station in direct nearness to the planet, it was necessary to inject that station into a strictly calculated trajectory which was selected with great accuracy. Even the smallest deviations in the value of speed which is transmitted to the automatic interplanetary station during the final acceleration sector would cause the station to miss the planet by a considerable distance. Errors in the speed value of 1 to 3 meters/sec during a full speed of more than 11,000 meters/sec and errors in the direction of speed of 0.1 to 0.3 degrees might lead to a change in the minimum distance of the automatic interplanetary station from Venus of about 100,000 km. Such magnitude of

deviation would also be caused by an error in the starting time of the rocket of 1 minute.

Deviations of the trajectory of the automatic interplanetary station from Venus might also take place due to the fact that the position of Venus is only known with approximate accuracy. Due to that fact, the calculation of deviations of the orbit of the automatic interplanetary station from Venus might be so erroneous as to cause the station to miss Venus at a distance which would exceed the planet's radius. The principal source of this error is the insufficient accuracy of astronomical unit measurements (average distance from the Earth to the Sun) which determines the scale of the solar system. A more accurate knowledge of an astronomical unit is extraordinarily important for cosmic flights.

For the above mentioned reasons, very accurate measurements of the flight trajectory and also the possibility of slight mid-trajectory corrections with the help of special devices are necessary, in order to assure an impact of the interplanetary station on the planet Venus.

By sufficiently accurate trajectory measurements during a large flight sector of the automatic interplanetary station, it will be possible to conduct corrections of astronomical units.

3. THE MEASUREMENT-GUIDANCE COMPLEX

For the purpose of guidance of the automatic interplanetary station and for determining its orbit and two-way communication with the station up to a distance of 100 million km, an automatized measurement radio-technical complex was constructed.

The construction of that complex has placed before Soviet scientists and engineers a number of serious problems connected with assuring a communication at long distances, with high requirements of accuracy in determining the coordinates, and the necessity of reliable operation of the instruments during an extended period of time.

The entire flight trajectory of the cosmic rocket can be divided into three sectors: the flight sector of the heavy artificial Earth satellite; the starting sector of the cosmic rocket from aboard the heavy satellite, and the flight sector of the automatic interplanetary station under the influence of gravitational forces in the direction toward Venus.

Measurements of trajectory elements of the heavy Earth satellite were accomplished by means of special installations which were distributed over the territory of the Soviet Union. Information on the operation of the junctions and aggregates of the satellite was received by radio telemetry stations which are established on the territory of the Soviet Union, and also by special ships on the oceans.

The launching of the cosmic rocket from aboard the heavy Earth satellite was regulated and controlled by telemetry systems.

After the separation of the automatic interplanetary station, a measurement complex of the near-Earth sector, which was designed for conducting orbital and telemetry measurements, went into operation. At each measurement point of the near-Earth sector, were established special radio-technical transmitting and receiving-recording installations, as well as parabolic antennas with instruments for the purpose of program control.

Determination of the actual orbit during the departure of the automatic interplanetary station from the Earth at a distance of more than 100,000 km was accomplished by radio-technical devices installed at the center for long-distance cosmic radio communication. This same center has conducted the reception of telemetry information and the regulation of the instruments of the interplanetary station during the entire duration of the flight. Over a special radio-command line corresponding instruments of the automatic interplanetary station were turned on or off; the transmission speed of telemetry information was regulated; power sources were reactivated, etc.

The operation of all devices on the distant flight sector of the automatic interplanetary station was conducted by a special program which determined the duration of the communication sessions, their periods and the modes of operation of the instrumentation.

For the purpose of receiving radio signals at long distances, was utilized a narrow-band, low-noise receiving installation. This requires a sufficiently accurate calculation of values of the receiving and transmitting frequencies, taking into consideration the doppler effect. For the purpose of maintaining a constant frequency on the input of the narrow-band filters of the receivers, which are installed aboard the interplanetary station and at the measurement points, the receiving and transmitting frequencies were supplemented by prognosticating doppler corrections.

During a departure of the station to distances which are measured in tens- and hundreds-of-million km, the strength of the signal which reaches Earth is very insignificant. For instance, at a distance of 70 million km, 1 square meter of the Earth's surface will receive only 10^{-22} watt. For the purpose of receiving such

weak signals, even by utilizing superhigh sensitive receivers, antennas with large surfaces are required.

At the centers for long-range cosmic radio communication were constructed large antennas, which make it possible to receive radio signals from sources which are located at astronomical distances from the Earth. These antennas can be pointed at any given point in the sky with an accuracy up to several angular minutes. The guidance programs are automatically fed to electronic computers which regulate the antennas.

All measurement data is transmitted over automatic lines into the coordinating calculation center, where the processing of trajectory measurements is conducted with the help of high-speed electronic computers and the prognosticating of the movement of the automatic interplanetary station is conducted. This center also calculates the program for the antenna's guidance. The coordinating calculation center carries out the directing duties of all ground measurement centers in accordance with a predetermined program.

4. THE STRUCTURE OF THE AUTOMATIC INTERPLANETARY STATION

The automatic interplanetary station is an apparatus equipped with a complex of radio technical and scientific instruments, a system for orientation and guidance, a programming device, a thermostat system, and power supply sources.

The automatic interplanetary station (Fig 3 and 4) is constructed in the shape of a hermetically sealed body consisting of a cylindrical part with two lids. Inside the hermetically sealed body of the interplanetary station are installed, on a special instrument frame, all necessary devices and the blocks containing the chemical

batteries. Outside of that body are installed a part of the detectors of the scientific instruments, two panels with solar batteries, screens of the system of temperature regulation, and elements of the orientation system.

To one of the panels with solar batteries is fastened a block with temperature detectors for the investigation of variations in thermal coefficients of various coatings under conditions of extended presence in interplanetary space at various distances from the Sun.

In addition, on the outside of the station's body are installed four antennas. One of these antennas is a directional antenna with a parabolic shape having a diameter of about 2 meters. This antenna secures the communication with the interplanetary station at long distances from the Earth and the transmission of a large quantity of information in a short period of time.

Two cross-like antennas are installed on the panels with the solar batteries. These antennas are semidirectional and are designed for communications at medium distances from the Earth.

One omnidirectional antenna is a shaft with the length of 2.4 meters which is designed for transmission of information and for determining trajectory parameters during the near-Earth flight sector.

The largest dimensions of the station (without taking into account the antennas and solar batteries) are: length, 2,035 mm; diameter, 1,050 mm. The weight of the automatic interplanetary station is 643.5 kg.

The panels of the solar batteries and the parabolic and shaft antennas were in a folded position up to the moment when the interplanetary station separated from the cosmic rocket. After separation, the shaft antenna and the panels with the solar

batteries unfolded immediately. The parabolic antenna does not unfold until the automatic interplanetary station approachs Venus.

The construction of the station secures the maintenance inside of the hermetically sealed body of the initial gas pressure of about 900 mm Hg during the duration of the entire flight.

The screens of the temperature-regulation system, which are installed on the cylindrical part of the automatic interplanetary station, open and close the radiating surface by rotation, increasing or decreasing correspondingly the elimination of heat which is discharged during the operation of the instruments aboard the rocket. Control of the operation of the screens and the ventilators, which are installed inside the body of the station, is carried out with the help of an automatic programming device with a system of temperature detectors which are installed at points of greatest heating or over-cooling. In this manner was solved the problem of securing a normal-temperature mode of the instruments aboard the interplanetary automatic station during the entire flight trajectory from the Earth to Venus, when the station comes closer to the Sun at a distance of up to 110 million km; i.e., during the period when the intensity of solar radiation increases more than twice.

Two panels with solar batteries, which are constantly oriented toward the Sun, assure a continuous recharge of the chemical power sources during the entire flight trajectory of the automatic interplanetary station, securing in that manner the energy supply to all systems and instruments aboard the station.

The radio technical complex of the automatic interplanetary station solves the following problems:

Measurement of the parameters of flight of the station in relation to the Earth.

Transmission to Earth results of measurements which were conducted aboard the station by the scientific instruments.

Transmission to Earth of information on the operation of the instruments aboard the station; pressure and temperature inside the station and on its body.

Reception from Earth of radio commands which control the operation of the instruments aboard the station.

Control of the operation of the instruments aboard the station was conducted by means of transmitting commands over radio lines from ground stations and also by the automatic programming devices aboard the station.

The orientation system of the automatic interplanetary station solves the following problems during the entire duration of flight over the trajectory:

The elimination of rapid rotation of the station, which occurred during the separation of the cosmic rocket that was launched from aboard the heavy artificial Earth satellite.

Securing the scanning of the Sun from any position of the station and the accomplishing of orientation of the solar batteries toward the Sun during the entire duration of the flight.

Assuring any necessary space correction of the station, as well as the stabilization of the station.

Assuring, during the approach toward Venus, the orientation of the super-directional (parabolic) antenna toward the Earth for the purpose

of obtaining a more high-gain transmission of scientific information and knowledge on the operation of the instruments aboard the station toward Earth.

The automatic interplanetary station is equipped with a complex of scientific instruments for the purpose of conducting physical measurements during its flight from the Earth to Venus. At the present time, measurements which are conducted by the instruments are designed for the investigation of cosmic space at a long distance from planets. Here are some of these instruments:

Instruments for the measurement of cosmic rays.

A magnetometer for the measurement of magnetic fields with a range from several gamma units up to 100 gamma units.

Counters for the measurement of charged particles of interplanetary gas and corpuscular solar fluxes.

Detectors for the registration of micrometeorite impacts.

Aboard the automatic interplanetary station is located a pennant with the image of the state emblem of the Soviet Union (Fig 5). The emblem represents the Earth and is constructed in the form of a sphere with a diameter of 70 mm. The material used is a titanium alloy. On the outside of the sphere's surface are imprinted the contours of our continents. The surface of the seas and oceans is of a blue coloring and the continents are yellow-golden.

Inside that spherical pennant is located a memorial medal with the image of the state emblem of the USSR. On the other side of this medal is imprinted a diagram of the solar system with the orbits of Mercury, Venus, Earth, and Mars. This

diagram is located right in the center of the medal. Around the edge is imprinted "Union of Soviet Socialist Republics - 1961".

The reciprocal position of the planets corresponds to the moment of approach of the automatic interplanetary station toward the planet Venus. The spherical pennant is placed in a special protective cover, the external surface of which is shaped from pentagonal elements made of stainless steel. These elements have imprinted on them the state emblem of the USSR and the words "Earth-Venus, 1961".

The launching of the automatic interplanetary station toward the planet Venus uncovers new perspectives for direct study of cosmic space and the planets of the solar system.

The first interplanetary route is paved.

RADIO MOSCOW (9.8 mc), 1800 PST, March 2, 1961

The Interplanetary Station headed for Venus has developed serious trouble in its telemetry system.

During the last interrogation on February 27, 1961, the high-frequency transmitter did not respond properly. In addition, fadeouts occurred.

Due to the fact that a consecutive interrogation session was scheduled for March 4, 1961, a special test was made on March 2 which revealed a malfunction in the permanent beacon transmitter.

Radio contact with the Interplanetary Station is therefore lost. An intensive investigation is now underway to determine the reason for this failure. Sabotage during assembly is not excluded.

According to the latest available data, the station is still following its strict trajectory, and it will approach the planet Venus as scheduled.

PRAVDA, March 3, 1961
TASS Communique

As a result of data processing of trajectory measurements which were obtained during a number of interrogation sessions it was established that the flight of the Automatic Interplanetary Station toward the planet Venus is continuing along a trajectory which is very close to the calculated.

At 12:00 Noon, Moscow time, on March 3, 1961, the Station will reach a distance of 6,683,600 km from the surface of the Earth. The Station's coordinates at that time will be as follows: 1° 15' southern latitude and 69° 30' eastern longitude. The Station's velocity at that time will be 4,166 meters per second. The Station still

remains on the border of the constellations of Pisces and Citus, almost on a straight line between the stars Beta Citus and Alpha Andromeda.

The right ascension of the Interplanetary Station at that time will be: $0^h21'31''$; declination: $1°15'3''$.

Processing of telemetry information has revealed that the systems and aggregates aboard the Station have functioned in a normal manner. The temperature and pressure inside the Station were maintained within the desired limits. The solar batteries have assured a normal charge for the chemical power sources. The solar orientation system operated reliably.

Our tracking stations were unable to establish contact with the Interplanetary Station on February 27, 1961.

Since February 27, intensive attempts have been made to establish radio contact with the Station whenever the Station has been in direct line of visibility with the territory of the Soviet Union.

Table 1. Details of interplanetary station position as a function of 10-day-interval periods given in Figures 1 and 2

Period No.	Date (0 GMT)	Distance from Earth, 10^6 km	Distance from Venus, 10^6 km	Distance from Sun, 10^6 km	Right ascension, h and m	Declination, deg
1	22 Feb.	3.4	74	145	0 27	-1.0
2	4 Mar.	6.9	60	142	0 22	-1.5
3	14 Mar.	11	48	138	0 16	-2.0
4	24 Mar.	15	36	134	0 10	-2.25
5	3 Apr.	21	27	129	0 08	-2.25
6	13 Apr.	28	19	124	0 10	-1.25
7	23 Apr.	37	13	119	0 18	0.0
8	3 May	47	7.5	115	0 32	2.0
9	13 May	59	3.1	111	0 51	4.5
10	19-20 May	70	0.1	109	1 09	6.5

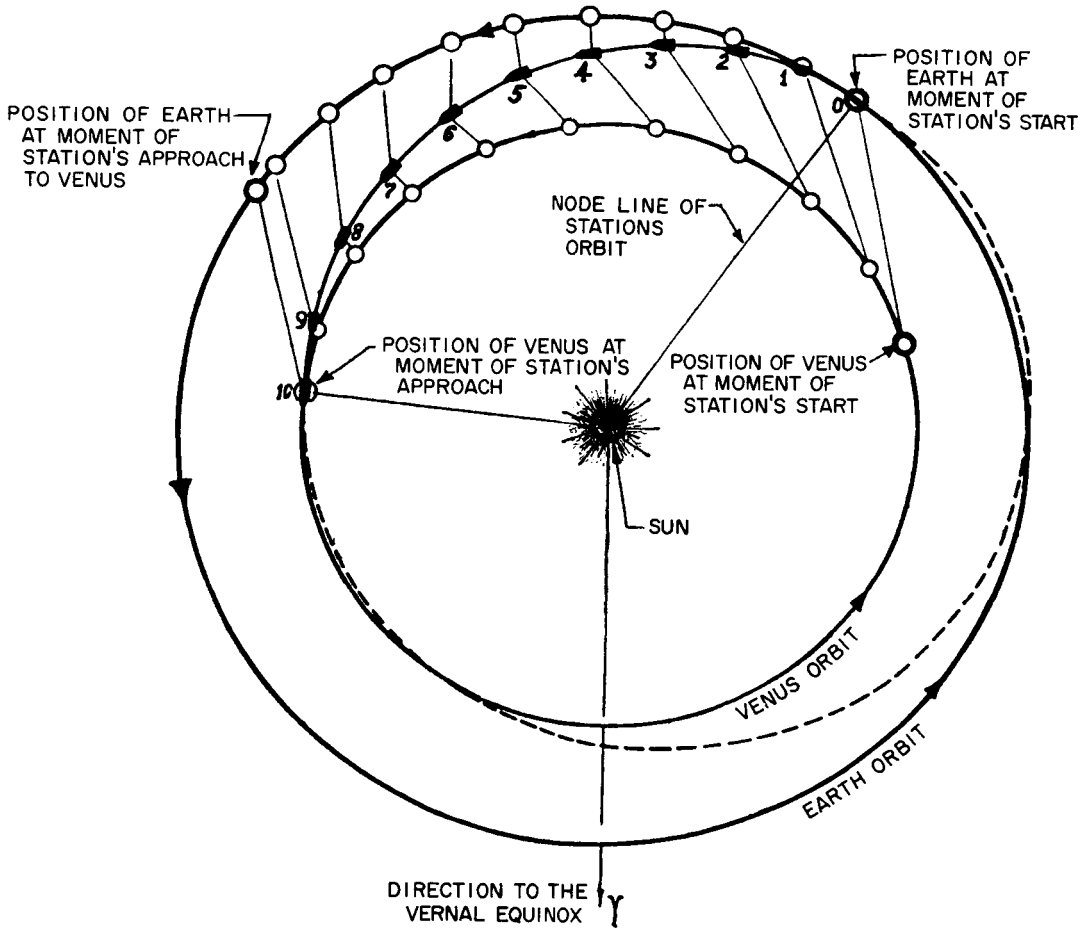


Figure 1. Movement of interplanetary station in relation to Sun as projected on plane of ecliptic. Numbers indicate position of station every 10 days (see Table 1)

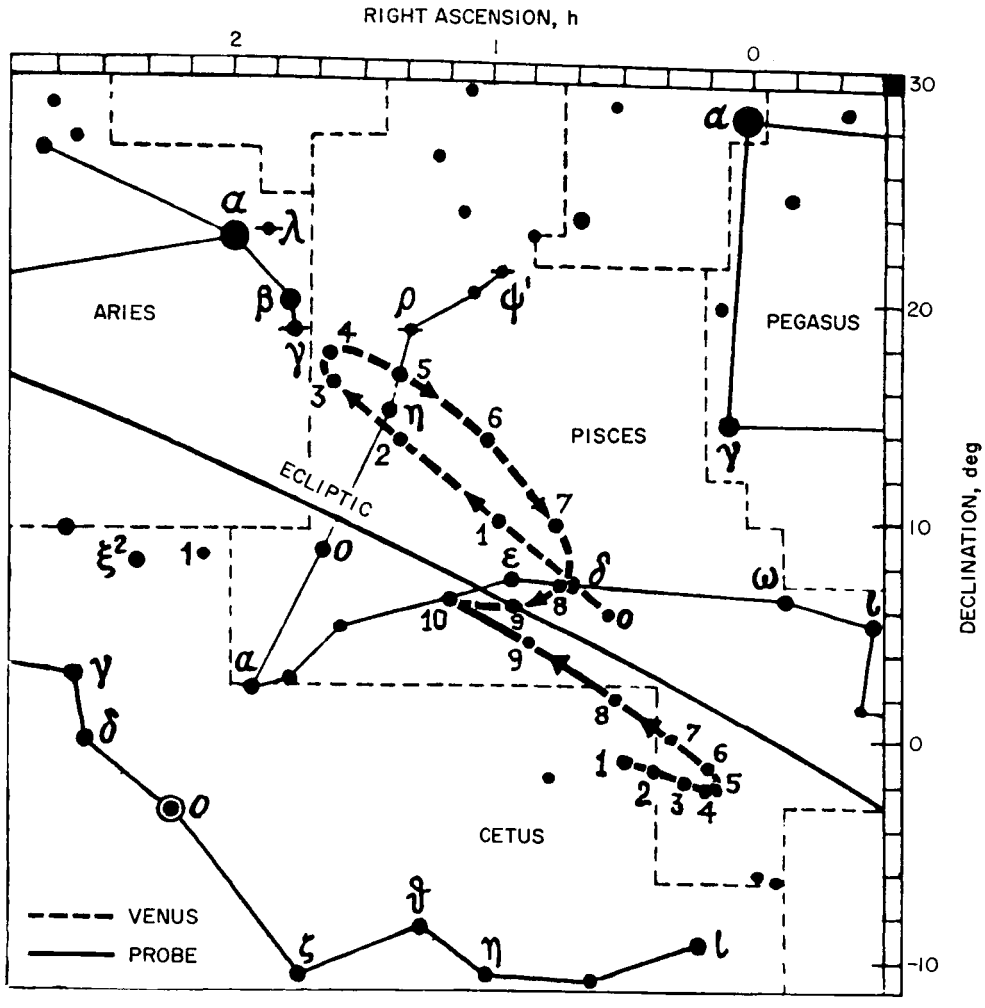


Figure 2. Movement of Venus and interplanetary station. Numbers indicate positions of station and Venus every 10 days (see Table 1)

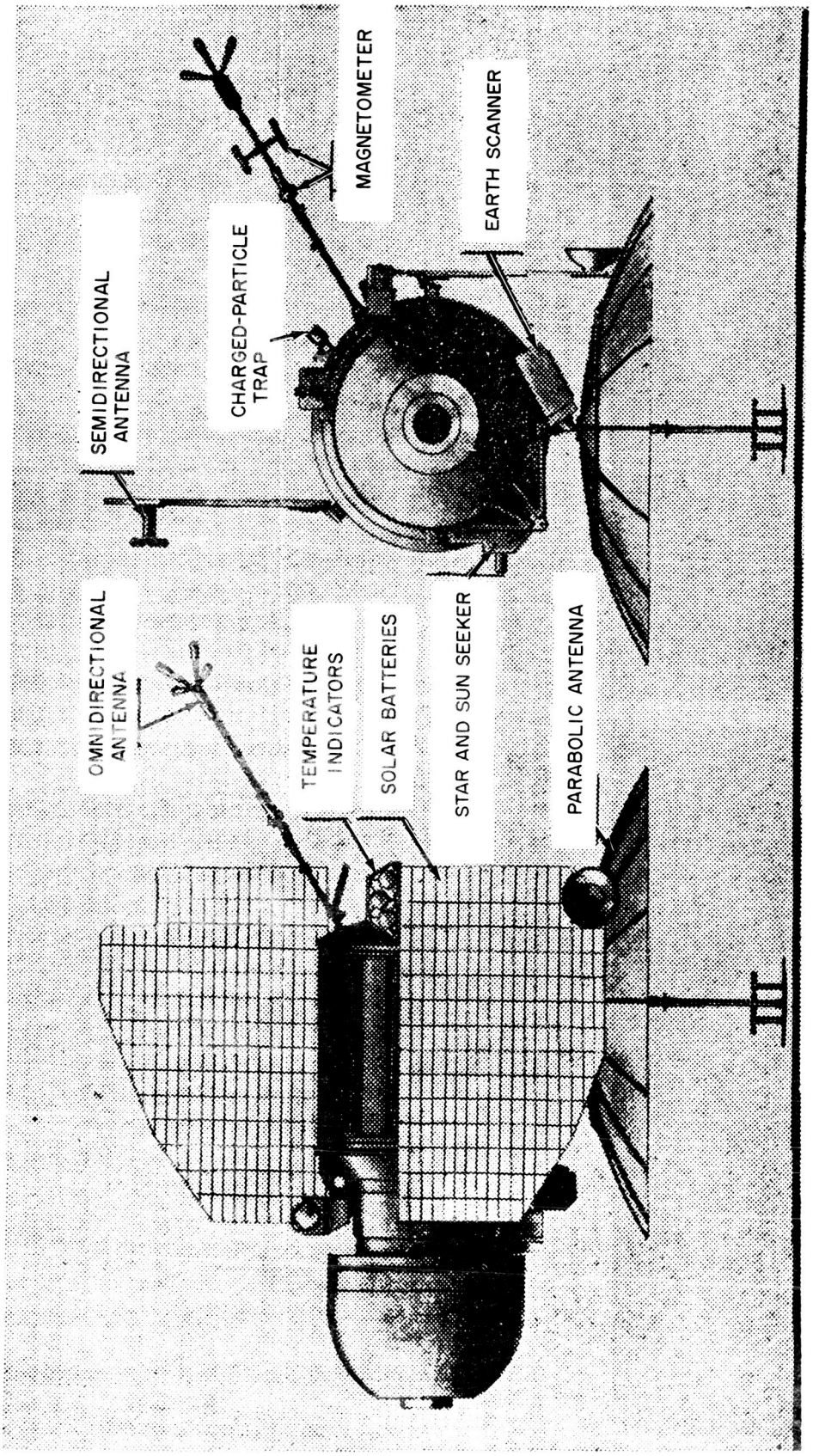
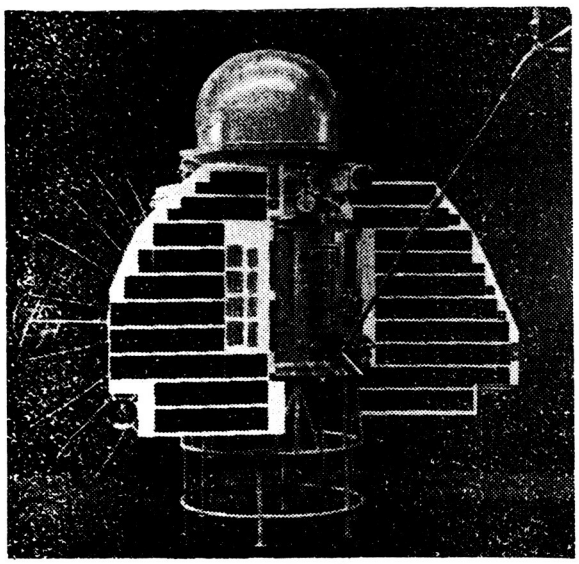
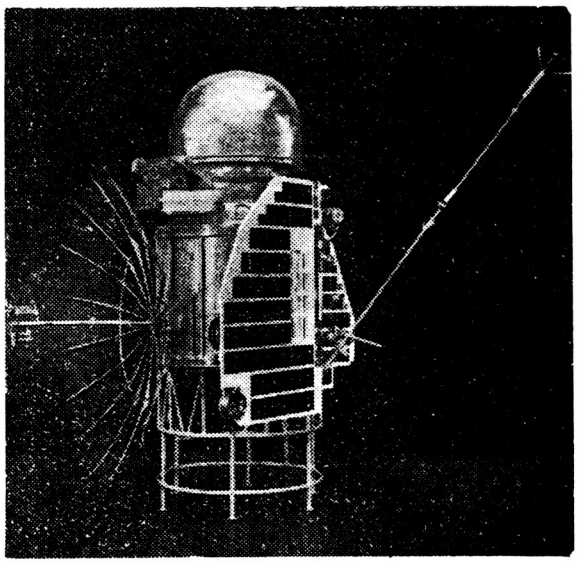


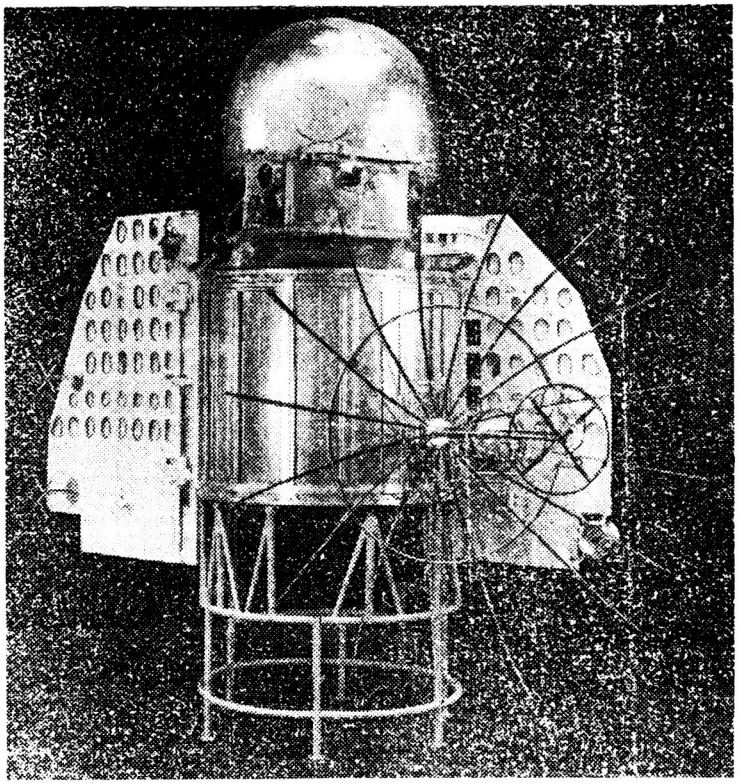
Figure 3. Detailed view of interplanetary station



FRONT VIEW



SIDE VIEW



REAR VIEW

Figure 4. Automatic interplanetary station on assembly stand

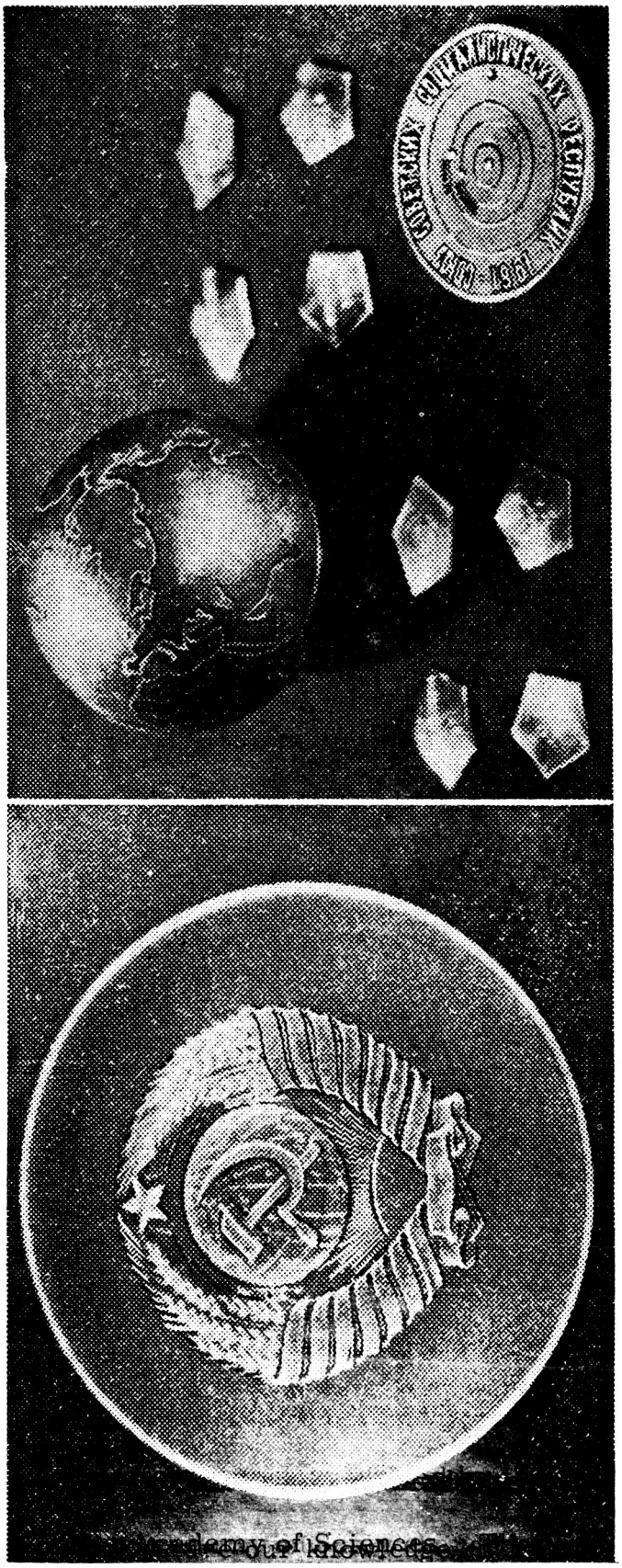


Figure 5. Face of medallion which is enclosed in sphere (left), and spherical pennant, pentagonal cover elements and back side of medallion